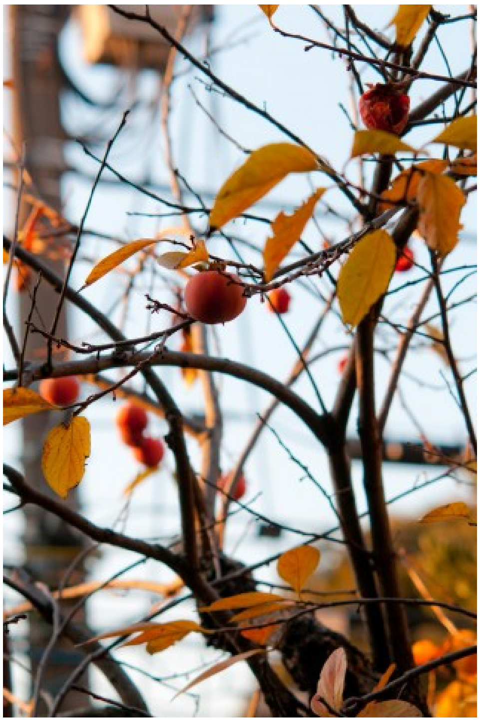
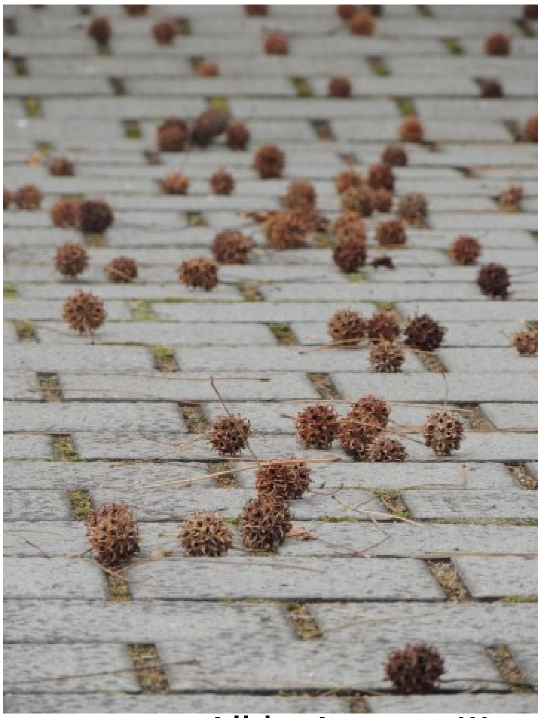
November 2015

AHPNW NEWSLETTER





All in Autumn!!!

CONTENTS

GENERAL

■ ICR2015 was held at Yokohama Japan

Yokohama hosted the 24th International Institute of Refrigeration (IIR) International Congress of Refrigeration (ICR2015) from August 16 to 22, 2015. Seamlessly organized by the Japan Society of Refrigerating and Air Conditioning Engineers (JS-RAE), ICR2015 was the refrigeration event of the year and a first for Japan.

Held just once every four years, ICR events are highlights in the refrigeration world, and ICR2015 was no exception. With a varied program encompassing plenary presentations, technical summary lectures and posters covering all refrigeration fields, technical tours providing an insight into cutting edge technology applied in Japan, and attractive accompanying persons' activities enabling participants to experience several aspects of Japanese culture, ICR2015 more than lived up to all participants' expectations. ICR2015 attracted 1,183 participants from 56 countries, along with 98 Public Forum participants, and featured almost 750 presentations in 11 parallel sessions.

Source; JARN ,September 25, 2015

MARKET & POLICY

■ Review of the Global Air Conditioner Market in the First Half of 2015(Asia)

The Southeast Asian market varies by country. The growing middle class boosted growth in the RAC segment. It is estimated that the entire Southeast Asian air conditioner market will see 9.8% year-on-year growth.

Indonesia

Temperatures were high in January and February, leading to rapid growth in the RAC market, although growth slowed in March. Sales in May fell by 7% year on year. However, during the January—June period, the Indonesian RAC market recorded 8.2% growth.

Owing to shrinking export volumes and a 5% year-on-year depreciation in the rupiah, the country experienced rising commodity prices, resulting in uncertainty over the future and curtailed consumer appetites.

Rising pressure on investment was an added drag on the local economy, and a number of commercial construction projects have been postponed. The cost of importing packaged air conditioners (PACs) rose dramatically, causing a 15% drop in the market.

The Indonesian market was dominated by cooling-only air conditioners, and the penetration rate of inverter air conditioners is lower than in neighboring countries. With the growing middle class, inverter air conditioners enjoy untapped market potential. All mainstream brands in Indonesia now feature inverter air conditioners in their product portfolios.

Thailand

It has been more than one year since the military coup last May, and the market has gradually recovered. The Thai air conditioner market in the first half of 2015 recorded 2.1% year-on-year growth, with PAC growth standing at 7.5%. Future market prospects are not optimistic, however, due to the worsening economic bubble in the local market.

The Electricity Generating Authority of Thailand (EGAT) has improved the efficiency of electric appliances launched in 2015 with a grade 5 rating by applying global testing standards. The Seasonal Energy Efficiency Ratio (SEER) is adopted for grade 5 inverter air conditioners.

Vietnam

The Vietnamese air conditioner market has made great strides forward in the first half of 2015 compared with other markets in Southeast Asia thanks to seasonable weather and favorable economic conditions. The country has seen scorching temperatures in all major cities since the beginning of April.

RAC sales increased by 18.5% year on

year, and PAC sales saw 21.1% year-on-year growth. Southern Vietnam is dominated by cooling-only air conditioners, while the northern region mainly sees heat pump air conditioners. In addition to big cities with strong market potential, markets surrounding big cities have also started to grow thanks to the country's large young demographic.

Expensive electricity rates in Vietnam have boosted market growth for inverter air conditioners. The share of inverter air conditioners is higher than in neighboring countries, taking 20% of the total market. Inverters are especially popular in the two key cities of Hanoi and Ho Chi Minh.

Malaysia

Implementation of the Goods and Services Tax (GST) from April 1, 2015, caused a spike in air conditioner sales in March. After the GST was implemented in April, air conditioner demand fell sharply in Malaysia. Commodity prices also rose at this time, which further diminished consumer appetites for RACs. According to statistics from GfK, the Malaysian RAC market saw 20% year-on-year growth in March; however, this growth rate fell by 30% in April and the market has been limping along since then. Malaysia boasts a RAC penetration rate as high as 64%. The market therefore contains less untapped market potential. PAC sales in the first half of 2015 were flat year on year.

Malaysia postponed implementation of its original R22 air conditioner phase-out plan from this July to December, causing minor chaos in the industry. R22 air conditioners reportedly saw hot sales in June. Daikin launched R32 RACs in Malaysia in October 2014.

India

Many Indian companies complained about lower-than-expected business performance in the first half of this year. Mild weather in April impeded sales growth until the beginning of scorching temperatures in May, but temperatures dropped down again in June with the arrival of the monsoon.

Indian air conditioner market growth in the first half of 2015 is estimated at 6%, far below industry expectations. PAC growth was slightly higher than the same period of last year. Ceiling cassette indoor units are often used for PACs.

The Bureau of Energy Efficiency (BEE) plans to introduce a mandatory energy labeling scheme for inverter air conditioners in 2018.

South Korea

The South Korean Ministry of Strategy and Finance downgraded its projected economic growth rate for 2015 from 3.8% to 3.1%. Public works projects have been declining, but the private housing market has begun to show brisker activity.

RAC sales have decreased by a significant 40%. For indoor units, floor-standing types are still popular and take a 60% share. Smart RACs are also popular in South Korea.

In the commercial air conditioner segment, VRF is the mainstream product. VRF posted 10% year-on-year sales growth while PAC sales decreased 10%.

Source; JARN, August 25, 2015

■Japanese Air Conditioner Sales in the First Half of 2015

According to the data from the Japan Refrigeration and Air Conditioning Industry Association (JRAIA), domestic Japanese shipments of room air conditioners (RACs) in the first half of 2015 recorded 4,272,498 units, down 10.9% from the same period of the previous year.

RAC shipments dropped sharply during the period from January to April 2015, down 22%, 24.3%, 14.4%, and 14.8%, respectively, from the same months of the previous year. These drops occurred mainly due to the reaction to the spike in demand prior to the consumption tax increase that went into effect April 1, 2014.

From May to July this year, temperature trends in Japan changed month by month and RAC shipments changed month by month accordingly. This May was visited by a spell of record-breaking heat in Japan. In Tokyo, the average of daily high temperatures for May was the highest recorded during the past 140 years. Domestic shipments in May were favorably influenced by the hot weather and regained positive growth of 1.9%. In June, however, temperatures did not rise due to unseasonably cool weather. Domestic shipments slowed down, recording a 4.3% drop.

After the end of Japan's rainy season was announced in July, Japan was visited by intense summer heat waves, and consumers flocked to the air conditioner floors of retail chains. Shipments then began to show signs of a full-scale recovery.

According to the three-month forecast through October announced by the Meteorological Agency, temperatures will be similar to or higher than normal years in most parts of Japan. The RAC sales race is therefore expected to last for longer than usual. Replacement demand is also expected to be relatively strong going into the second half of this year.

RAC demand tends to be greatly affected by summer weather. In recent years, however, heat pump RACs have become accepted as heating equipment in winter in mainly Japanese mild climate regions. Manufacturers have been developing heat pump RACs with improved heating capacity and retailers have been promoting sales of these products year- round at RAC sales floors. RACs now tend to be used for a longer period of time.

Thanks to those favorable reasons, total shipments of RACs for the year may reach 8-8.5 million units, continuing to top 8 million units for six consecutive years.

Source; JARN, September 25, 2015

■ Promotion Policies for Heat Pump Industry

According to the Ministry of Environmental Protection, the China's central government has allocated RMB 26.3 billion (US$ 4 billion) to prevent and control the air pollution during the last three years. In addition to the financial input, the air pollution classification has also been established and improved. With the policy support, the clean energy industry such as the air-source heat pump industry is ready for rapid development.

Several local governments released a series of heat pump water heater promotion policies and standards recently. By the end of May 2015, heat pump water heaters had been included in the mandatory or recommended policies or standards of many provincial and city governments, such as Fujian Province Green building Design Standard', `Guangdong Province Green Low-carbon Building Technologies and Product Catalog', 'Hubei Province Building Energy-saving Products, Technologies and New Wall Materials Application Directory', 'Hunan Provincial Government Procurement Catalog of Resource-saving and Environment-friendly Products', and `Jiangxi Province Green Hospital Building Evaluation Criteria'.

Qingdao City government announced the 'Regulation of Implementing the Qingdao City Policies on Promoting the Development of Clean Energy Heating' recently. Each clean energy heating project may receive up to RMB 30 million (US$ 4.7 million) subsidy. The regulation went into effect on August 20, 2015 and will end on December 31, 2017.

Source; JARN, October 25, 2015

OTHERS

■HPTCJ Receives the 2nd redrik Setterwall Award

The Heat Pump and Thermal Storage Technology Center of Japan （HPTCJ), nominated by the Japanese government to be a participant in the Implementing Agreement on Energy Conservation through Energy Storage of the International Energy Agency(IEA), is carrying out international research activities in collaboration with researchers at universities and companies in order to promote the development and diffusion of Japan's thermal storage technologies.

Now, in recognition of the HPTCJ's achievements concerning thermal storage technologies realized in close collaboration with industry, the HPTCJ was awarded the second Fredrik Setterwall Award at Greenstock Conference 2015 held in Beijing, China, in May this year.

Prof. Yamaha, Chubu University receives an award on behalf of HPTCJ

Source; JARN, July 25, 2015

Dissemination of Systems to Use Sewage Heat Energy and Future Prospects

Masaki Nakao, Extraordinary Professor of Osaka City University

Yasuhisa Nakaso, Manager in charge of Customer Relations Division, the Kansai Electric Power Company

ABSTRUCT

Heat pumps using unused heat sources, such as river water, sewage and groundwater etc., attract attention as a key technology for energy conservation as a renewable energy technology. This paper shows the benefits of these unused heat sources, combined with the principle of the heat pump system. And also, although the heat pump system using a heat of raw sewage has not been popular so far because of the handling difficulties, a new technology with screen device and heat exchanger for sewage has developed, the outline of this system will be introduced here.

KEY WORDS: Water heat source, Sewage heat, Sewage heat utilization systems

1. Introduction

Heat pumps using renewable energy attract attention as a key technology for energy conservation in the utilization of heat. Because of the mechanism employing a refrigeration cycle (Figure 1), the closer the temperature of the intended use and the temperature of heat source are, a greater efficiency is achieved in principle, hence, the selection of a heat source is important. Also, in addition to the temperature level, it is essential whether to obtain a required heat quantity with the least loss (the power for heating medium supply or a difference in temperature with the refrigerant for heat pump) (Figure 2).

From a standpoint of convenience, using the atmosphere as a heat source is advantageous, as it is easily accessible from any locations. If a required amount of water is obtained directly as a heat source, however, a “water heat source” is advantageous for the operation of a larger heat pump system, since water is 1,000 times greater than air in density. Moreover, a temperature difference between refrigerant and water at the time of heat exchange becomes smaller compared to air. Thus, a water heat source is effective for ensuring a large capacity and improving performance.

Figure 3 shows the relations between renewable energy and the unused heat sources. Also, various water heat sources that can be utilized as a heat source are listed on the top of the right column of unused heat sources. Accessible heat sources are available in the places unexpectedly close to us, including the groundwater, river water, factory effluent, sewage water, etc. Obviously, heat recovery from manufacturing processes is effective as well.

By the way, when looking around the world, we found that relations between types and forms of the unused heat sources and heat demand vary widely by regions. Since the temperature of the unused heat sources, excluding artificial ones, are susceptible to the meteorological conditions and easiness of access to heat sources is different, as shown in

Figure 4, selection of a heat source must be made in individual cases.

2. Improvement of utilization efficiency of heat pumps and positioning of sewage heat

As to sewage heat, our main topic, we find slightly different situations in Tokyo or Osaka vs. Sapporo or Sendai, etc. even we see the relations between monthly average air temperatures and the sewage water temperatures in the cities of Japan only, as shown in Figure 5. Namely, the sewage water temperatures in Sapporo, Sendai, etc. are “cooler in summer and warmer in winter” compared to air temperatures, as it has been pointed out, while the sewage water temperatures are higher than the air temperatures at night in Tokyo, Osaka, etc. However, the air temperatures have risen in the cities where heat island phenomena are intensified. Thus, the advantages as a heat source for air conditioning in summer are growing.

The research and development project on the utilization of sewage heat was carried out for four years between 2010 and 2014 by Osaka City University, Chuo Fukken Consultants Co., Ltd., Sogo Setsubi Consulting Co., Ltd. and the Kansai Electric Power Company with financial assistance from NEDO (hereinafter referred to as “NEDO Sewage Heat Research”), which will be shown later, in order to focus on the development of utilization for hot water supply, because the research activities were based in Osaka. Application of sewage heat to meet the air conditioning demand in the cold regions is also effective. Highly efficient, large systems are already in operation in Makuhari Shintoshin area and Shibaura Water Reclamation Center where the treated water is used as heat source.

The NEDO Sewage Heat Research started with an in-depth survey on heat potential of sewage water. The relations between average air temperature and sewage water temperature in Osaka are shown in Figure 6 below. The sewage flow varies greatly hour by hour, depending on what kind of buildings are in the upstream of the sewage conduits. For example, in the case of thermal storage hot water supply using nighttime electricity service, it is important to know when a heat pump is in operation and the status of necessary sewage flow in the nighttime when the heat pump operates.

Also, though omitting detailed explanation of calculation methods, heat utilization potential of sewage water in Osaka is shown in Figure 6 above. As indicated in this figure, an unexpectedly large amount of heat sources exist under our feet in the cities where we live.

3. Forms and methods of utilizing sewage heat

Various methods to use sewage heat are shown in Figure 7. The treated sewage water shown in this figure is easier to handle, compared to the untreated sewage water. Generally, large volumes of sewage water are treated. Accordingly, there are few problems related to the water volume. However, its use is restricted in the areas near the sewage treatment plants.

On the other hand, in the case of the untreated sewage water, the areas available for utilization of heat expand and the heat can be extracted from the locations near the installed heat sources. Accordingly, the construction cost, power for heat conveyance and heat loss are expected to be reduced. However, there are problems related to handling the untreated sewage water, i.e., in particular, degradation of heat transfer performance of a heat exchanger due to contamination by organic materials and microbes as well as the recovery of its performance. In addition, water flow becomes smaller in the upstream of sewage conduits. Depending on the types of buildings in the upstream areas, it is difficult to obtain necessary water flow at a necessary timing. Therefore, when we think about utilization of the heat from the untreated sewage water, we need to know in advance the water collection system in the sewage conduits near utilization locations, sewage temperature and sewage flow in each season and each hour.

4. Situations in Japan and overseas

In the research on utilization of sewage heat by NEDO in the past, utilization of sewage heat both in Japan and overseas was surveyed in order to avoid technical challenges and rework (Figure 8). Various types are under development or in use in the overseas countries, compared with Japan.

The systems that employ the treated sewage water as a heat source in Japan include the district heat supply system in Makuhari, air conditioning systems at sewage water treatment plant site in Tokyo and others. In other countries, such cities as Zurich, Switzerland (Figure 9) and Helsinki, Finland (Figure 10) are operating large-scale district heat supply systems. These systems are not much different from those introduced in Japan (Figure 8 above). However, the district heat supply system in a suburb of Zurich (Figure 11) that is temperature changeable only in winter season is an advanced system newly designed in conjunction with building expansion. Such an advanced system is not yet in place in Japan.

On the other hand, regarding utilization of the treated sewage water as a heat source, we know some examples, including a case in the athletes' village in Whistler, Canada (Figure 12) and a few cases in Switzerland (Figure 13 left, Figure 14), where the locations using heat are scattered and dispersed, hence, the treated sewage water is utilized after heat exchange as heat source water for heat pump equipment. In district heat supply systems, as the heat loss increases as conduits are extended, the network utilization of heat source water for heat pumps can be recognized as a new form of extended use of energy. Such a type has not been introduced yet in Japan. In particular, the recently completed system in a suburban district of Zurich (Figure 14) realizes labor saving, cost reduction and compactification.

Then, regarding direct utilization of the treated sewage water, we know two cases in Japan, i.e., in Koraku (Tokyo) and Morioka, where such water is utilized as a heat source for district heat supply (Figure 8 below). In respect of utilization of the untreated sewage water as a heat source, Germany and Switzerland are the leading countries in this field (Figure 15). In Switzerland, the Ministry of Energy provides support to NPOs that promote the diffusion of renewable energy technology. In Germany, some of more than 800 urban corporations responsible for the management of community infrastructure throughout the country promote sewage heat utilization under assistance from the Federal Ministry for Environment, Nature Protection and Nuclear Safety. We have visited Germany and Switzerland for a survey mission, where we saw active exchanges taking place between the German speaking researchers in Switzerland and the German researchers. The guidebooks for sewage heat utilization, whose contents are almost similar, are published by the German Federal Ministry for Environment and the Switzerland Ministry of Energy.

At a research meeting on sewage heat utilization in Berlin, to which we visited on another occasion, we saw the operation of a system using a "built-in-the-field type" sewage heat exchanger that employs a nested structure of large-diameter steel conduits, as well as a system developed by a German company Huber that houses a heat exchanger in a container (Figure 16). So far, we have introduced some of domestic and overseas cases and organized the forms of utilization with a focus on the relations between heat sources and each demand (Figure 17).

5. Details of the project sponsored by NEDO

As we mentioned at the beginning, the research and development project on the utilization of sewage heat was carried out for four years between 2010 and 2014 by Osaka City University, Chuo Fukken Consultants Co., Ltd., Sogo Setsubi Consulting Co., Ltd. and the Kansai Electric Power Company with financial assistance from NEDO (NEDO Sewage Heat

Research). From a viewpoint of developing new markets and solving technical problems in the less popular areas, development work was implemented with a goal of cost reduction, while focusing on hot water supply with anticipating a capacity of 30 to 500 kW per location with using the untreated sewage water as a heat source.

Surprisingly, the detailed data of heat transfer characteristics on various materials and heat transfer surfaces in the untreated sewage water, including performance degradation associated with outgrowth of biofilms (biological membranes), have not been collected. The layout of the experimenting system installed in Chishima Sewage Treatment Plant, Osaka, and its photos are shown in Figure 18 left. In such an experimenting environment, inside-of-conduit type and outside-of-conduit type heat exchangers (Figure 19) as well as low-cost, compact pumping screen (Figure 20) which is indispensable for an outside-of-conduit type heat exchanger were researched and developed. The advantages and disadvantages of each developed item and the detailed heat transfer performance will be noted on a future opportunity.

In terms of system simplicity, inside-of-conduit type heat exchangers are better, since they have no moving parts. If a larger capacity is required, outside-of-conduit type heat exchangers will be a choice. As for the outside-of-conduit type heat exchangers, the falling liquid film type, shown in Figure 19, is significantly superb in heat exchange rate and its performance degradation is relatively small, thanks to the cleaning effect of the untreated sewage water flowing on the surface of heat transfer conduit. The appearance and a chart of heat transfer characteristics are shown in Figure 18 right. Also, its pairing pumping screen is fitted with an automatic cleaning function, thus, a product that can be housed in a standard manhole with a diameter of 1,200 mm has successfully been developed.

6. Features of Japanese products

The Japanese industry is good at manufacturing high-performance, mass-produced products. If performance requirements for a product are given, we can expect high performance, highly functional products from the Japanese industry. As in the case of cynically called Galapagos cell phones, many Japanese products incorporating rarely used functions or performance more than required, contrasted with the smartphones of worldwide common specifications, could not become mainstream products. When we see even the products for which Japan once pioneered the market, we find many cases where Japan is defeated in the competition with China, Taiwan or South Korea. Sometimes Japan lags behind in planning expertise or the move toward software-focused products as seen in cases of the advanced western companies. But, why is Japan fallen behind the Asian countries? Some people insist that the Asian companies who are leaders in a certain industry analyze the Galapagos products developed by Japanese companies through reverse engineering and reconstitute them by eliminating unnecessary functions, or by bold investments, and then they ensure their competitiveness.

While turning our eyes to the systems, mainly toward those in Europe we are introducing here, we see that most of the systems with a capacity of over several hundred kW have heat pumps consisting of individual components such as compressor or heat exchanger. Some systems employ ammonia as refrigerant. The system itself is a product made to order, which evaluates properly the requirement level or reliability level of each part in the system and spends enough money where necessary, while cutting corners in a good sense where costs can be reduced. Also, the data for performance evaluation are traceable in preparation for the occurrence of malfunction. In many cases, the engineers called “rack builders” are responsible for them.

On the other hand, heat pump package products manufactured by the Japanese makers are often employed in each building, including heat source water network. For wider use of the Japanese products, development of highly flexible products that can satisfy the needs of various countries is desirable, not to mention low price and high performance. In order to meet such needs, we believe that it is important to provide the designers and engineers with the information including the cases of product introduction and tap into system engineering in each country.

7. Measures to promote diffusion by preparing potential maps

As flow volume in sewage conduits is used in designing a sewage heat utilization system, a method is required to measure or estimate a flow volume in conduits where sewage heat utilization is planned. Figure 20 shows a concept to estimate flow volume at a manhole where heat utilization is planned, based on the existing measurement values of a sewage pumping plant. The figure shows a method to estimate by using a total floor area of the buildings in water catchment area. Also, sewage flow volume per unit time by types of buildings can be used.

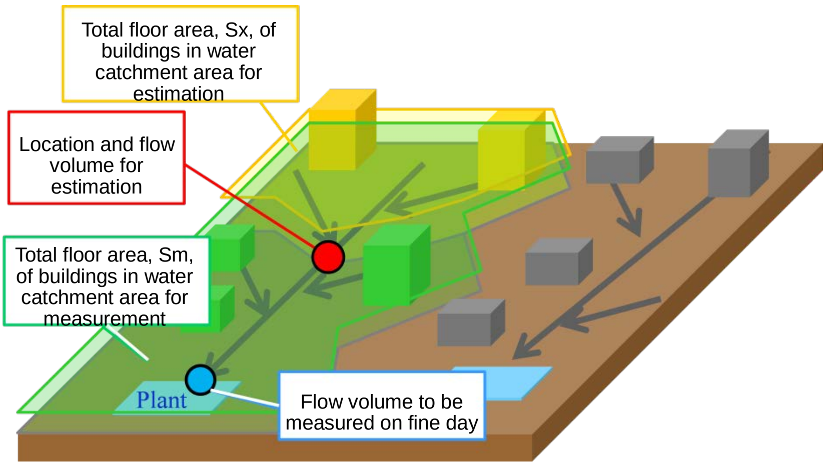


Figure 21: Sewage flow volume estimation method

A method to prepare sewage heat potential maps was developed in a joint project of the Ministry of the Environment and the Ministry of Land, Infrastructure, Transport and Tourism. Sewage heat potential maps show a usable amount of sewage heat in conduits. The map preparation manual will be utilized as a tool to increase the opportunity of utilizing sewage heat and provide assistance to planning and design by each local government.

Though Figure 4 is just an example of calculation to suggest a study image, it shows that the City of Osaka has a network of trunk sewage conduits with a total length of about 250 km, which has a potential worth some one fourth of the total district heat supply capacity in Japan. If conduits with a lower level sewage heat potential are included, we can say that the potential for heat utilization in the facilities near conduits is huge.

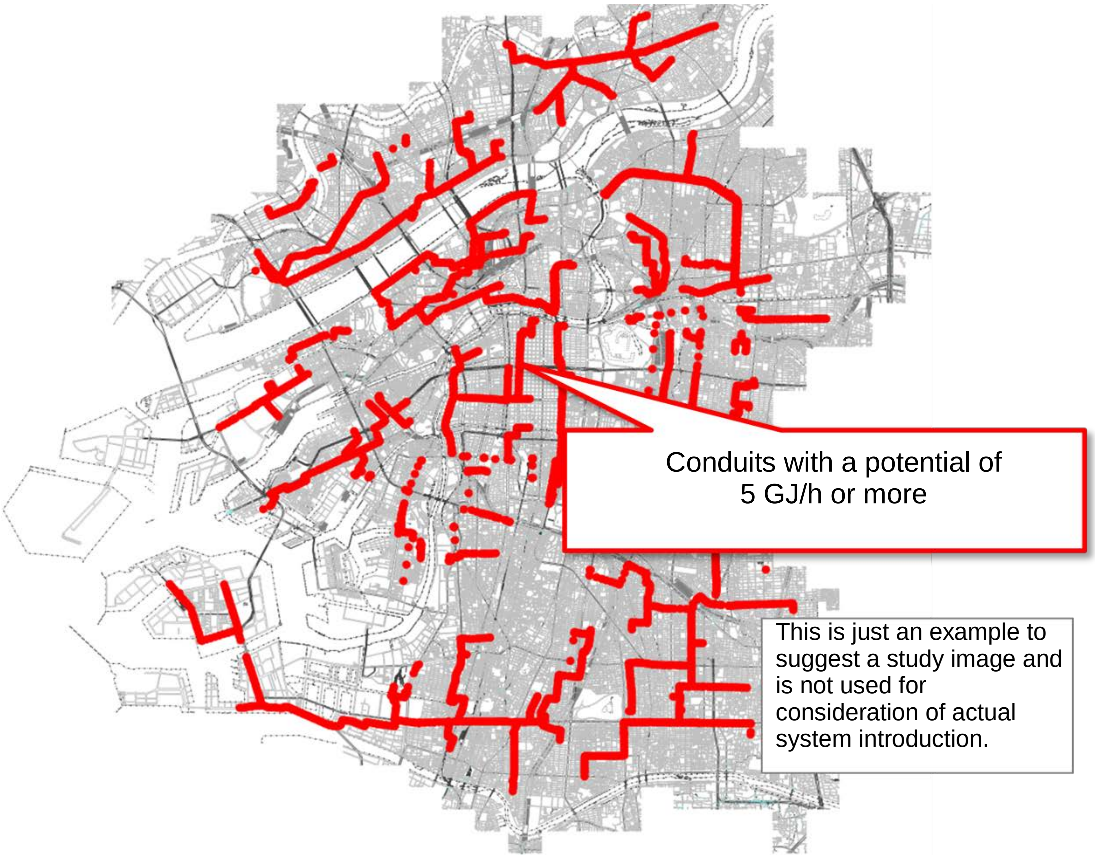
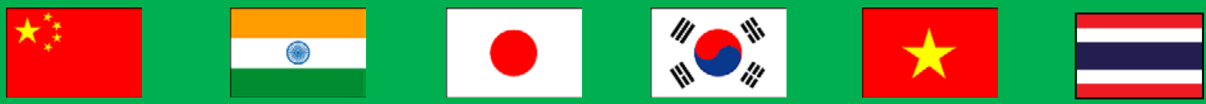


Figure 22: Example of estimation of a potential for sewage heat utilization in trunk sewage conduits of cities

8. Future prospects based on institutional reform

Diffusion of sewage heat utilization systems with a capacity of 30 to 500 kW, using the untreated sewage water as a heat source, developed by us, is yet to begin in Japan. As of 2011 when NEDO started research activities, the untreated sewage water was allowed to use, only if it is pumped up in the special areas under the Act on Special Measures concerning Urban Renaissance. Then, following the research activities jointly with the Ministry of Land, Infrastructure, Transport and Tourism and other efforts, the ministry that also supervises sewage networks continued study work and formed a committee to study utilization of sewage heat. And, employment of a pumping system was permitted as it was mentioned in the utilization plan in accordance with Low Carbon City Promotion Act. In 2015, a revision made to the Sewage Act enables commercial operators to use sewage heat by installing inside-of-conduit type heat exchangers.

Also, the committee has approved preparation of maps of potential sewage heat utilization in each city of Japan as well as implementation of feasibility study by the local governments that consider sewage heat utilization. Our research and study group has conducted several studies for introduction in the actual cases and intends to continue activities toward new introduction.



Asian Heat Pump Thermal Storage Technologies Network

To promote energy savings and combat global warming, there is an urgent need to spread efficient heat pump and thermal storage technologies on the demand side. Countries in Asia, which are enjoying rapid economic growth, should coordinate with one another to spread this technology. Five to ten years from now, Asia will become a global economic powerhouse and heat pump technologies will play a considerable role in all sectors. Asian countries will therefore need to address common issues and problems that have already been faced in Europe and North America. Concerning the building of connections and networks among countries, it is essential to share information on diffusion policies, technology trends, applications, etc., and then to make incremental improvements. Further, situations which can or should be handled through collaboration should be handled flexibly, on a case-by-case basis, with the collaboration of all countries. In order to encourage the use and development of heat pump and thermal storage technologies in Asian countries we have established AHPNW in 2011.

Participating Countries and Entities

CHINA: China Academy of Building Research (CABR)

INDIA: The Energy and Resources Institute (TERI)

JAPAN: Heat Pump and Thermal Storage Technology Center of Japan (HPTCJ)

KOREA: Korea Testing Laboratory (KTL)

VIETAM: Hanoi University of Science and Technology (HUST)

THAILAND: King Mongkut's University of Technology Thonburi (KMUTT)

Please visit our website for more information.

⇒http://www.hptcj.or.jp/e/ahpnw/tabid/571/language/en-US/Default.aspx